50X1-HUM

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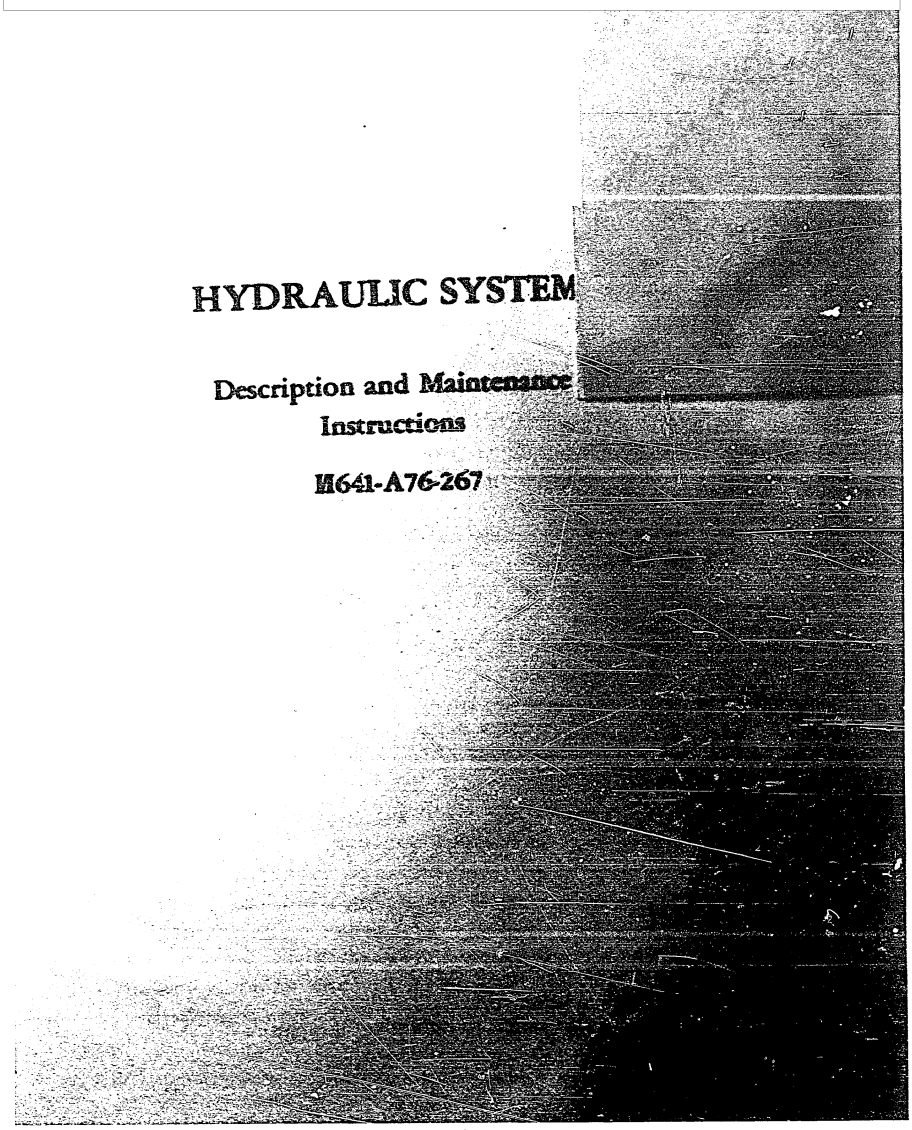

HYDRAULIC SYSTEM

Description and Maintenance Instructions

M641-A76-267

50X1-HUM

C O N T E N T S

I. DESCRIPTION

A. APPLICATION AND BASIC CHARACTERISTICS

APPLICATION

1. The submarine's hydraulic system is designed to drive the following operating mechanisms:

- stern plane and vertical rudder tilting rams, bow plane tilting and rigging rams;
- hoists of night altiscope НЗНГ-8 and attack periscope ПК-8.5;
- hoist of masts of devices FLAG, NAKAT, VAN, RAMKA and snorkel unit;
- hydraulic mechanisms of ballast and negative tank vent valves and sea cocks;
- engine cooling sea valves;
- rams of torpedo tube muzzle door;
- hydraulic mechanisms of snorkel exhaust and air induction flapper valves;
- hydraulic mechanisms of main engines exhaust and air induction flapper valves.

CHARACTERISTICS OF MAIN UNITS

2. The hydraulic fluid is spindle oil AV. The total amount of oil in piping and tanks amounts to about 1200 litres including:

- 300 litres in service tank;
- 190 litres in spare tank;
- 170 litres in emergency tank;
- 35 litres in hand pump tank;
- about 540 litres in piping.

3. Motor-driven pump:

Designation ..... ЭМН 1.25/100

Type ..... vertical, three-screw direct-coupled to electric motor

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Output with viscosity of 5°E	21 lit/min.
Discharge working pressure	100 kgf/sq.cm
Vacuum suction head	4 m H_2O
Working medium	oil with viscosity of 4 - 12°E
Speed:	
- at 220 V	2600 r.p.m.
- at 320 V	3150 r.p.m.
Power requirements:	
- at 220 V	7.0 kW
- at 320 V	9.0 kW
Direction of rotation	left-hand if viewed from pump shaft end
Type of electric motor	MMB-68KV
Electric motor power output:	
- at 2600 r.p.m. and 220 V	7.3 kW
- at 3150 r.p.m. and 320 V	9.5 kW
4. Hand pump:	
Output	0.33-2 lit/min.
5. Air-hydraulic accumulators	
Main accumulator capacity	60 lit.
Reserve accumulator capacity	35 lit.
Working medium	oil and air
Working pressure	100 kgf/sq.cm
6. Capacities of oil tanks	
Service tank	300 lit.
Spare tank	190 lit.
Emergency tank	170 lit.
Hand pump tank	35 lit.
7. Compressed air flask	
Capacity	400 lit.
Working pressure	100 kgf/sq.cm
8. Oil cooler	
Designation	MO 2,4-3
Type	surface-action [illegible] of pipes

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Oil pressure ..... not over 10 kgf/sq.cm

Cooling surface ..... 3.4 m^2

Number of pipes ..... 114 pcs

Pipe diameter 10x1.2

Weight:

when dry ..... 156 kg

when operating ..... 186 kg

9. Hydraulic system pipe line consists of the oil and air pipings.

The oil piping is made of steel pipes measuring 57x3.0, 38x2.5, 32x2.5, 25x2.5, 22x2.0, 14x1.6 and of copper pipes measuring 14x2.0, 9x1.5 and 6x1.5.

The pipes, 57x3.0, are connected by flanged joints while the remaining pipes by pipe unions.

The pumps are connected to the main by rubber hoses. The packing gaskets used in flanged joints are made of paronite, grade YB-10, and those used in pipe unions are copper. The stop fittings are made of steel.

The working pressure in the pressure line is 100 kgf/sq.cm, in the drain line within 2 - 25 kgf/sq.cm.

The piping has been tested for tightness under hydraulic pressure: pressure line - 125 kgf/sq.cm, drain line - 32 kgf/sq.cm.

The air piping is made of bimetal pipes, [illegible] of copper pipes, 14x2.0 and 6x1.5. The pipes are connected by pipe unions.

The packing gaskets used in the pipe unions are made of copper. The locking fittings are of steel.

The working pressure in the piping is 100 kgf/sq.cm.

The piping has been tested for tightness under air pressure of 100 kgf/sq.cm.

B. GENERAL DESCRIPTION
(see Dwg.22)

10. The hydraulic system piping is laid throughout the ship. It is subdivided into a pressure line and a drain line.

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In compartments I, III and VII these lines interconnect through link pipes with valves 54, 100, 136. Branches from the pressure and drain lines run to the operating mechanisms.

The hydraulic system operates from the pumping plant. The latter includes three motor-driven pumps (two main and one reserve pumps; each of the pumps can operate in succession as a reserve one), three air-hydraulic accumulators (two main and one reserve), one compressed air flask, a service oil tank, an oil cooler and a hand pump.

The emergency motor-driven pump, 170-litre tank and oil cooler are located in compartment III for use in the event of failure in compartment VII.

11. Description of the pumping plant (see Dwg.21). The suction pipe connections of the motor-driven pumps located in compartment VII are connected with the service tank through pipe A. The delivery pipe connections are joined through pipes Б and the pressure main to the air-hydraulic accumulators and the cut-off valve located in compartment II. The air chambers of the air-hydraulic accumulators are connected through pipe Д with the compressed air flask, located in compartment IV.

Each pump, air-hydraulic accumulator, oil tank and flask can be disconnected from the hydraulic system by stop valves.

The screw-down non-return valves installed on pipe Б are provided for independent (parallel) and successive charging of every air-hydraulic accumulator.

The service tank is connected through pipe Г with the drain line. Pipe В mounts two filters and a back pressure valve.

The parallel-connected filters can be cleaned without stopping the system.

The back pressure valve adjusted for a pressure of 2 kgf/sq.cm maintains the said pressure in the drain line, thus improving operating conditions for the packing collars.

To facilitate the servicing of the system the pressure piping is connected to the drain piping and the latter in

turn to the suction piping by means of link pipes with stop valves.

The pumps draw oil from the service tank, deliver it under pressure through the pressure line into air-hydraulic accumulators and force compressed air from them into the flask. It results in increase of the air pressure. With the pistons in the extreme top position, the air pressure reaches 100 kgf/sq.cm.

When the operating mechanism is engaged, the oil flows to one of the mechanism chambers through the pressure line. The oil from the opposite chamber flows along the drain line and through a filter enters the service tank. The drain piping is furnished with an oil cooler to reduce the oil temperature.

12. Operation of the pumping plant.

The motor-driven pumps can operate in two duties:

(a) manual control with the aid of buttons START (ПУСК) and STOP (СТОП);

(b) automatic control.

In automatic operation the motor-driven pumps are switched on and off depending on discharging or charging of the air-hydraulic accumulators.

Departments III and VII are equipped with lamp signalling boards:

White lamps indicate operation of the electric pumps, green lamps, charging of the air-hydraulic accumulators, and a red lamp, discharging of the third air-hydraulic accumulator.

Signalling of charge-discharge of the air-hydraulic accumulators as well as starting and stopping of the motor-driven pumps are effected by means of limit switches I_t, II_t, III_{t1}, III_{t2}, and limit switches I_b, II_b, III_b installed on the top and bottom covers of the air-hydraulic accumulators, respectively.

When discharging the air-hydraulic accumulators, the motor-driven pumps can be started in the following sequence:

(a) Lamp MAIN AIR-HYDRAULIC ACCUMULATOR I CHARGED (1 ОСНОВНОЙ ГИДРОАККУМУЛЯТОР ЗАРЯЖЕН) on the signalling boards goes on at the beginning of discharge of the first

air-hydraulic accumulator. As soon as the first air-hydraulic accumulator is discharged, the second air-hydraulic accumulator starts discharging.

(b) Lamp MAIN AIR-HYDRAULIC ACCUMULATOR II CHARGED (II ОСНОВНОЙ ГИДРОАККУМУЛЯТОР ЗАРЯЖЕН) on the signalling boards goes out at the beginning of discharge of the second air-hydraulic accumulator.

(c) When the second air-hydraulic accumulator completes discharges, two motor-driven pumps are started simultaneously and the lamps on the signalling boards light up to indicate operation of the respective motor-driven pumps. If oil from the air-hydraulic accumulators is still consumed, the third air-hydraulic accumulator starts discharging.

(d) Lamp RESERVE AIR-HYDRAULIC ACCUMULATOR CHARGED (РЕЗЕРВНЫЙ ГИДРОАККУМУЛЯТОР ЗАРЯЖЕН) on the signalling boards goes out at the beginning of discharge of the third air-hydraulic accumulator.

As soon as about 6 litres of oil is consumed, the third pump is started, and the respective signal lamp lights up on the signalling boards.

(e) Red lamp SYSTEM DISCHARGED (СИСТЕМА РАЗРЯЖЕНА) lights up to indicate that the third air-hydraulic accumulator is discharged.

The air-hydraulic accumulators can be charged in any sequence by all the operating motor-driven pumps. Lamp SYSTEM DISCHARGED goes out at the beginning of charge of the third air-hydraulic accumulator. As any of the air-hydraulic accumulators becomes charged, the respective signal lamp lights up to indicate its charging.

When all the air-hydraulic accumulators become charged, the pumps stop, and the signal lamps indicating their operation go out.

The motor control circuit also makes it possible:

(a) to vary combinations in switching of the motor-driven pumps to equalize the operating hours. For example, when the second air-hydraulic accumulator becomes discharged the pumps can be started in the following combinations:

Nos 1 and 2, 2 and 3, 1 and 3. At the same time the remaining third pump shall be started as soon as 6 litres of oil is consumed from the third air-hydraulic accumulator;

(b) to operate the emergency pump of compartment III under both manual and automatic control. In automatic operation the emergency pump shall be started when the first air-hydraulic accumulator becomes discharged. Manual control of the pump is also possible;

(c) if the second air-hydraulic accumulator has failed, start one pump (the second pump being disengaged) upon discharging the first air-hydraulic accumulator. The second pump should in this case be disengaged to avoid frequent engagement of the pumps and prolong the service life of the electrical equipment.

Operation of the pumping plant is controlled by signalling boards two of which are installed in compartment III and one in compartment VII. The signalling boards are supplied from the switch mounted in compartment III (see instructions for light signalling system).

The pressure line is always under pressure varying from 100 kgf/sq.cm (with accumulators fully charged) to 77.5 kgf/sq.cm (with main accumulators discharged) or to 72.5 kgf/sq.cm (with accumulators fully discharged).

By-pass slide-valves 62 and 95 are provided for use in the event of failure of electric interlocking system of the pumps and air-hydraulic accumulators (i.e. the charging of the air-hydraulic accumulators is over but the pumps continue to work).

With the increase in pressure in the pressure line up to 110 +3 kgf/sq.cm the by-pass slide-valve sends a hydraulic pulse to the valve units of the pumps, which change over the pumps to idle running.

Cut-off valve 99 is installed on the pressure piping in compartment III to prevent loss of oil in the event of a burst in the piping.

With the increase of the oil flow speed up to [illegible] (that corresponds to an oil consumption of 6 lit/[illegible]

cut-off valve operates automatically and cuts off the air-hydraulic accumulators from the pressure line.

To equalize pressures before and after the cut-off valve upon correcting the trouble in the pressure piping, and to return the cut-off valve to its initial position use is made of a jumper with valve 98.

If the cut-off valve does not operate itself it can be force-closed with the aid of a remote controlled air drive from the intermediate pressure air piping.

13. All the operating mechanisms fall into two groups: one-chamber devices and two-chamber devices.

Hoists of FLAG, NAKAT, VAN, RAMKA and snorkel masts belong to one-chamber devices whereas the rest of the mechanisms belongs to two-chamber devices. The mechanisms are governed by hand- and foot-operated and electromagnetic control valves.

14. One-chamber hoists of FLAG and NAKAT are governed by foot-operated three-way control valves, and one-chamber hoists of VAN, RAMKA and SNORKEL are governed by hand-operated three-way control valves.

Throttles installed before the hand-operated control valves on the pressure and drain pipes regulate the time of the mechanism hoisting and lowering.

Before the foot-operated (pedal) control valves the throttles are installed only on the drain pipes because these control valves have throttles in the pressure chambers.

Screw-down non-return valves 79 and 80, installed before the control valve on the pressure pipe prevent the mast from lowering spontaneously in the event of the pressure drop in the pressure line in the course of mast hoisting.

15. Two-chamber hoists of night altiscope ПЗНГ-6 and attack periscope ПК-8.5, of plane tilt rams, hydraulic mechanisms of vent valves, ballast tank sea cocks, [illegible] tank sea cocks, engine air induction and exhaust [illegible] valves are governed by hand-operated four-way control whose slide-valves direct the oil from the pressure one of the chambers of the operating mechanism the same time the oil from the other chamber [illegible]

the operating mechanism piston via the control valve to the drain line (see Dwg.20). Thus, pipes connecting the control valve with the operating mechanism operate under pressure alternately.

The three-way control valve operates in a similar way.

16. The hydraulic mechanisms of the snorkel exhaust and air induction flapper valves and the engine cooling sea valves are governed by four-way electromagnetic control valves. The slide-valves of these control valves are set to motion with the aid of the electromagnets switched over from the engine control panel in compartment V. Should the remote-controlled electric drive fail to operate, the said control valves can be employed with the aid of the hand drive.

Turning the key on the control panel closes one of the electromagnets, and the control valve connects the operating mechanism chambers with the pressure and drain mains (see Dwg.19). With the electromagnet open, the slide-valves of the electromagnetic control valve move to the neutral position thus communicating both of the operating mechanism chambers with the drain line. In this case the mechanism can be operated manually with the electric remote control previously disengaged.

17. Slide-type by-pass cocks are fitted before the hydraulic mechanisms of the vent valves, ballast tank sea cocks, negative tank sea cocks, engine exhaust and air induction flapper valves and snorkel exhaust flapper valve. By-pass valves are fitted before the stern planes and the vertical rudder. The by-pass cocks and valves serve to disconnect the mechanisms from the control valve and to transfer oil flow from chamber to chamber when the mechanisms are controlled manually (see Dwg.19).

18. For oil cleaning purposes the oil filters are installed before the service and emergency tanks on the drain and drainage pipings, and also on the pressure piping of the control valves.

Gauges 60 and 117 are mounted before the valves on the drain main to check the [illegible]

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19. The pressure and drain lines and the air piping in compartments I, III, V and VII are fitted with pressure gauges to read the pressure in the hydraulic system.

Besides, pressure gauges are installed before the masts and tilting rams of the planes and rudder to read the pressure of these mechanisms.

Each motor-driven pump is fitted with a pressure gauge and a pressure vacuum gauge to check the filters for pressure built up and for degree of clogging.

20. The oil temperature in the system is read by temperature gauge 56, type KT-100, installed on the drain pipe in compartment VII.

21. Drainage piping laid from the hydraulic motor in the conning tower to a service tank in compartment VII serves to prevent the pressure increase in the housing of the hydraulic motor employed to rotate the ПЗНГ-8 night altiscope.

22. Safety slide-valves fitted on pipes at tilting rams of the planes serve to relieve from the overloaded ram chamber the excess pressure built up due to the action of the seas on the plane blade.

23. All the sections of the hydraulic system subject to formation of air locks are fitted with needle plugs to vent the air out of the mains and pipings because the presence of air in the hydraulic system results in intense oxidizing of oil and in disturbing the smooth running of the operating mechanisms.

CONTROL CIRCUITRY OF MOTOR-DRIVEN PUMPS
(see Dwg.23)

24. Motor-driven pumps No.1, No.2 and No.3 of the hydraulic system are installed in compartment VII, and the emergency electric pump in compartment III.

The electric motors of the pumps are started by magnetic stations СУ-1025, located in the immediate vicinity of the pumps. Pumps No.1, No.2 and No.3 operate from distribution box No.18 (main supply) and from distribution [illegible] (reserve supply) installed in compartment VII.

The emergency pump is fed with main power supply [illegible]

distribution board No.1 and with reserve power supply from distribution box No.2 which are installed in compartment III.

The covers of the air-hydraulic accumulators mount the limit switches operating from the air-hydraulic accumulator pistons.

Main air-hydraulic accumulators No.1 and No.2 have two contactors (I_t, I_b and II_t, II_b) each. Two contactors (I_t and II_t) are installed on the top cover, and the other two (I_b and II_b), on the bottom cover.

The reserve air-hydraulic accumulator has three contactors (III_{t1}, III_{t2} and III_b): two are installed on the top cover (III_{t1} and III_{t2}) and the third one (III_b), on the bottom cover.

Limit switches I_t, II_t and III_t serve to automatically stop the electric pumps with all the three air-hydraulic accumulators completely charged, and also to indicate that the air-hydraulic accumulators are charged or discharged.

Limit switches I_b and II_b serve to automatically start the main electric pumps.

Limit switch III_{t2} serves to automatically start the reserve motor-driven pump after six litres of oil is discharged from the reserve air-hydraulic accumulator.

Limit switch III_b serves to switch on the signalling system as soon as the hydraulic system is completely discharged. For the detailed description of the light signalling system and construction of the limit switches, see the maintenance instructions for the shipboard signalling system.

25. The motor-driven pumps can operate under the following conditions:

1. Manual control with the aid of buttons START and STOP.

2. Automatic control. The motor-driven pumps start and stop depending on the degree of charge of the air-hydraulic accumulators.

The motor-driven pump automatic control system makes it possible:

(a) to employ any two pumps as main pumps and any one as a reserve pump (from electric pumps No.1, No.2

(b) to automatically control motor-driven pumps No.1, No.2 and No.3 or the emergency pump;

(c) to automatically start two main pumps or the emergency pump upon discharge of air-hydraulic accumulator No.2 or No.1 (in the event of failure of air-hydraulic accumulator No.2 during operation of pumps No.1, No.2 and No.3 or in case of failure of air-hydraulic accumulator No.1 during operation of the emergency pump).

To select an operating duty of the pumps, provision is made for the following switches:

(a) universal switches $УП_1$ and $УП_2$ installed in compartment VII;

(b) three packet switches $ПП_1$, $ПП_2$ and $ПП_3$ installed in compartment VII;

(c) packet switch $ПП_4$ installed in compartment III.

Universal switches $УП_1$ and $УП_2$ serve to change over manual or automatic control of motor-driven pumps No.1, No.2 and No.3, and also to select a reserve pump.

Packet switches $ПП_1$, $ПП_2$ and $ПП_3$ serve to change over contactors of the air-hydraulic accumulators from the main and reserve pumps to the emergency pump.

Packet switch $ПП_4$ changes over the emergency pump from manual to automatic control.

MANUAL CONTROL OF MOTOR-DRIVEN PUMPS

26. To start motor-driven pumps No.1, No.2 and No.3 manually, take the following steps:

(1) put the handle of universal switch $УП_1$ to MANUAL CONTROL (РУЧНОЕ УПРАВЛЕНИЕ). As a result, contacts 50 - 12, 53 - 15 and 56 - 57 close the operating circuits of motor-driven pumps No.1, No.2 and No.3;

(2) close the packet switch supplying voltage to the control station and electric motor. The packet switches are installed in compartment VII;

(3) depress the START button of the respective pump. To stop the motor-driven pump, depress the STOP button.

To start the emergency motor-driven pump manually, do the following:

(1) set packet switch ПП$_4$ to MANUAL CONTROL. As a result, contact 28-29 closes the electric pump operating circuit;

(2) close the packet switch supplying voltage to the control station and electric motor. The packet switch is installed in compartment III;

(3) depress the START button. To stop the pump, depress the STOP button.

AUTOMATIC CONTROL OF MOTOR-DRIVEN PUMPS

27. To control the main and reserve motor-driven pumps automatically, follow the procedure below:

(1) put the handle of universal switch УП$_1$ to AUTOMATIC CONTROL (АВТОМАТИЧЕСКОЕ УПРАВЛЕНИЕ);

(2) put the handle of universal switch УП$_2$ to one of selected operating duties of motor-driven pumps;

(3) set packet switch ПП$_3$ to MAIN AND RESERVE PUMPS (ОСНОВНЫЕ И РЕЗЕРВНЫЕ НАСОСЫ);

(4) set packet switch ПП$_2$ to MAIN AND RESERVE PUMPS;

(5) set packet switch ПП$_1$ to OFF (ВЫКЛЮЧЕНО).

With the switches set to these positions, two main motor-driven pumps will start automatically at the moment air-hydraulic accumulator No.2 becomes discharged provided air-hydraulic accumulator No.1 has previously been discharged. This is the main operating duty.

Should air-hydraulic accumulator No.2 fail to operate, the main pumps can be started at the discharge of air-hydraulic accumulator No.1 (this is the emergency duty). To this end, set packet switch ПП$_2$ to OFF and packet switch ПП$_1$ to MAIN AND RESERVE PUMPS. Close limit switch ВП$_t$ in compliance with Item 87, and leave universal switches УП1 and УП$_2$ and packet switch ПП$_3$ in the same positions as indicated above.

28. To control the emergency electric pump automatically, proceed as follows:

(1) set packet switch ПП$_4$ to AUTOMATIC CONTROL;

(2) set packet switch ПП$_3$ to EMERGENCY PUMP (АВАРИЙНЫЙ НАСОС);

(3) set packet switch ПП$_2$ to OFF;

(4) set packet switch ПП$_1$ to EMERGENCY PUMP.

With the switches set to these positions, the emergency pump starts automatically when air-hydraulic accumulator No.1 becomes discharged.

29. Should air-hydraulic accumulator fail to operate, the emergency pump can be started at discharge of air-hydraulic accumulator No.2. To this end, close limit switch I_t in compliance with Item 87, set packet switch ПП$_2$ to EMERGENCY PUMP and packet switch ПП$_1$ to OFF, leaving packet switches ПП$_4$ and ПП$_3$ in the positions indicated above.

The main pumps and the reserve pump or the emergency pump stop when all the air-hydraulic accumulators become completely charged.

DESCRIPTION OF AUTOMATIC OPERATION
OF MOTOR-DRIVEN PUMPS
(see Dwg.23)

30. Discussed herewith is the operating duty, at which pumps No.1 and No.2 are main pumps, pumps No.3 is selected as a reserve one, and the main motor-driven pumps are started automatically at the discharge of air-hydraulic accumulator No.2.

All the air-hydraulic accumulators are charged, and the controls are set to the following positions:

(1) the knob of universal switch УП$_1$ to AUTOMATIC CONTROL;

(2) the knob of universal switch УП$_2$ to PUMP No.3 IS RESERVE (НАСОС № 3 РЕЗЕРВНЫЙ), PUMPS No.1 AND No.2 ARE MAIN (НАСОСЫ № 1 и № 2 ОСНОВНЫЕ);

(3) packet switch ПП$_1$ to OFF;

(4) packet switches ПП$_2$ and ПП$_3$ to MAIN AND RESERVE PUMPS;

(5) packet switches supplying voltage to input terminals of the stations and electric motors to ON.

Thus, the circuitry is ready for automatic operation.

Main air-hydraulic accumulator No.1 starts discharging. At the same time contact 36-37 of limit switch I_t closes and the lamp on the signalling board goes out. When air-

hydraulic accumulator No.1 becomes completely discharged, contact 34-35 of limit switch I_b will close, but motor-driven pumps No.1 and No.2 do not start since packet switch III_1 is open. Then air-hydraulic accumulator No.2 starts discharging. Contact 36-37 of limit switch II_t closes and the second lamp on the signalling board goes out. When air-hydraulic accumulator No.2 becomes completely discharged, contact 32-33 of limit switch II_b closes.

The starting circuit of motor-driven pumps No.1 and No.2 is thus completed.

P u m p No.1

For starting pump No.1 the starting circuit is from terminal 1 (50) through closed contacts 50-11 of universal switch $УП_1$, 11-36 of packet switch $ПП_3$, 36-37 of limit switches I_t and II_t, 37-22 of packet switch $ПП_3$, 22-4 of universal switch $УП_1$, 4-33 of packet switch $ПП_2$, 33-32 of limit switch II_b, 32-60 of packet switch $ПП_2$, and contact 60-61 of universal switch $УП_2$ to terminal 5 (61).

P u m p No.2

For starting pump No.2 the starting circuit is from terminal 1 (53) through closed contacts 53-11 of universal switch $УП_1$, 11-36 of packet switch $ПП_3$, 36-37 of limit switches I_t and II_t, 37-22 of packet switch $ПП_3$, 22-4 of universal switch $УП_1$, 4-33 of packet switch $ПП_2$, 33-32 of limit switch $II_в$, 32-60 of packet switch $ПП_2$, 60-62 of universal switch $УП_1$, and contact 62-14 of universal switch $УП_2$ to terminal 5 (14).

The operation of the control station is explained in the description and operating instructions for D.C. magnetic stations, series СУ.

As stated above, motor-driven pumps No.1 and No.2 start simultaneously.

When the oil consumption is considerable, the reserve air-hydraulic accumulator starts discharging. At the same time contact 36-37 of limit switch III_t closes, and the third

lamp on the signalling board goes out. As soon as 6 litres of oil is consumed, contact 21-22 of limit switch III_{t2} closes. This completes the starting circuit of motor-driven pump No.3.

P u m p No.3

For starting pump No.3 the starting circuit is from terminal 1 (56) through closed contacts 56-11 of universal switch $УП_1$, 11-36 of packet switch $ПП_3$, 36-37 of limit switches I_t, II_t, III_{t1}, 37-22 of packet switch $ПП_3$, 22-21 of limit switch III_{t2}, and contact 21-63 of universal switch $УП_2$ to terminal 5 (63).

With the further discharge of the reserve air-hydraulic accumulator, contact 43-40 of limit switch III_b, closes, and the lamp that indicates the complete discharge of the air-hydraulic accumulators lights up on the signalling board.

31. When motor-driven pumps No.1, No.2 and No.3 are running, the operating circuit is completed in the following way:

P u m p No.1

When pump No.1 is running, the operating circuit is from terminal 1(50) through closed contacts 50-11 of universal switch $УП_1$, 11-36 of packet switch $ПП_3$, 36-37 of limit switches I_t, II_t and III_{t1}, 37-22 of packet switch $ПП_3$, 22-4 of universal switch $УП_1$, and contact 4-12 of universal switch $УП_1$ to terminal 12.

P u m p No.2

When pump No.2 is running, the operating circuit is from terminal 1 (53) through closed contacts 53-11 of universal switch $УП_1$, 11-36 of packet switch $ПП_3$, 36-37 of limit switches I_t, II_t, III_{t1}, 37-22 of packet switch $ПП_3$, and contact 22-15 of universal switch $УП_1$ to terminal 15.

P u m p No.3

When pump No.3 is running, the operating circuit is from terminal 1 (56) through closed contacts 56-11 of universal

switch VII_1, 11-36 of packet switch III_3, 36-37 of limit switches I_t, II_t and III_{t_1}, 37-22 of packet switch III_3 and contact 22-57 of universal switch VII_1 to terminal 57.

As the air-hydraulic accumulators are charged, contacts 34-35, 32-33 and 43-40 of limit switches I_b, II_b and III_b will gradually open, but the electric pumps will continue to operate. They will stop as soon as all contacts 36-37 of limit switches I_t, II_t and III_{t_1} open.

C. DESCRIPTION OF INDIVIDUAL UNITS

AIR-HYDRAULIC ACCUMULATORS

(see Dwgs 1 and 2)

The air-hydraulic accumulators serve to maintain working pressure in the hydraulic system within specified values through compression of air in the air flask and to control operation (engagement and disengagement) of the motor-driven pumps.

32. The air-hydraulic accumulator consists of cylinder 153, top cover 154, bottom cover 160, piston 152 (see Dwg.1).

The cylinder is a steel piece. Its inner surface is lined with a brass layer and polished.

The top and bottom covers made of steel are attached to the cylinder with the aid of pins and are sealed with rubber rings.

The piston with rubber packing rings travels inside the cylinder. It serves for separating the air and oil chambers. On charging the air-hydraulic accumulator with oil, the piston travels up and presses on lever 175 which through a linkage acts on a limit switch (or on switches mounted on the top cover).

On discharging the air-hydraulic accumulator, the piston presses on locking device bucket 162 thus communicating both pipe connections with each other, and simultaneously presses on the lever and acts on a limit switch on the bottom cover.

The reserve air-hydraulic accumulator is similar to the main air-hydraulic accumulator with the only difference that its top cover mounts two limit switches, one of which operates as 6 litres of oil is left to complete charging, and the bottom cover has no locking device.

TANKS (see Dwgs 3, 4 and 5)

The tanks serve to store the reserve oil and to supply oil to the hydraulic system.

33. The 300-litre tank (see Dwg.3) is a welded structure of sheet steel. The tank casing has welds-on to receive pipes. Manholes 190 are provided for inspection and cleaning of the tank interior surfaces. Filler neck 186 is used for filling the tank with oil.

Oil is poured through screen 187. Arranged in the bottom of the tank is sump 192 with cock 191 used to drain sediment. The oil temperature in the tank is read by temperature gauge 193, and the oil level by level gauge 189.

34. The construction of tanks of 190, 170 and 35-litre capacity is similar to that of the 300-litre tank (see Dwgs.4 and 5).

CONTROL VALVES (see Dwgs.6, 7, 8 and 9)

The control valves are designed for remote control of the operating mechanisms.

35. The electromagnetic control valve (see Dwg.6) consists of two slide-valves (change-over slide valve with electromagnets and distribution slide-valve).

The control valve is provided with four connections to join pipes (one connection PRESSURE, one connection DRAIN and two connections TO CONSUMER).

Inserted into housing 211 of the distribution slide-valve is bush 221 sealed with rubber rings. Distribution slide-valve 222 moving inside the bush is set to the middle position by two rods 223 and spring 224. Change-over slide-valve housing 220 with electromagnets 215 is attached to the distribution slide-valve housing by pins. The change-over

slide-valve housing accommodates bush 219 incorporating change-over slide-valve 218.

With any electromagnet energized or with the handle of manual control tilted, the change-over slide-valve moves and imparts pressure from duct I to duct II or III depending on the direction of changing-over. Under the force of this pressure the distribution slide-valve is brought to one of the end positions and directs the oil from the pressure main to one chamber of the operating mechanism and simultaneously lets the oil flow from the other chamber to the drain main.

With the electromagnet deenergized (or with the handle turned to the middle position), the change-over slide-valve is brought to the middle position by spring 217. In this case the distribution slide-valve is also brought to the middle position by spring 224, and the operating mechanism chambers communicate with the drain line. For the functional diagram of the electric control valve see Dwg.19.

36. The hand-operated four-way control valve is shown on Dwg.7. Control valve housing 240 has press-fitted bush 239 with ground slide-valve 238 moving inside. The slide-valve is provided with inner boring for oil by-pass. The housing ends are plugged by covers 237 which in turn are sealed with rubber rings.

Valve 232 is in the lower part of the control valve to reduce the oil transfer when handle 244 is moved to the middle position. Valve 232 opens when the handle is turned clockwise or counter-clockwise and returns to its initial position under the action of spring 243 with the handle moved to the middle position.

The hand-operated three-way control valve (see Dwg.8) is similar in the construction and principle of operation to the four-way control valve, the only difference being in that the three-way control valve has three connections, two of which are used to connect with the pressure and drain pipe lines, and one to connect with the operating mechanism. For the

functional diagram of the hand-operated three-way and four-way control valves see Dwg.20.

38. The hand-operated two-way control valve (Dwg.9) consists of two housings 272 and 273 thread-connected together and sealed with a copper gasket. Control valve housing 272 accommodates valve disc 279 pressed against the valve seat by spring 271. Rod 276 has inner and side boring which communicates the inner chamber of the control valve with connection BLOWING. The rod end projecting from housing 273 rests on a shaped cam on handle 274.

In the position shown in the Drawing, connection TO CUT-OFF VALVE communicates with connection BLOWING.

When turning the handle, the rod rests on disc 279 shutting connection BLOWING, and displaces the disc thus permitting air to flow through the inner chamber to the cut-off valve.

With the handle being turned in the opposite direction, the valve disc actuated by spring 271 shuts off the air flow to the cut-off valve.

The rod is returned to its initial position by spring 27 The air from the air chamber of the cut-off valve is bled through connection BLOWING.

HAND PUMP

39. Hand pumps (see Dwg.10) are designed for filling the mechanisms and pipe lines with oil, for testing the hydraulic system for tightness, and for supplying oil to the hydraulic mechanisms.

The hand pump is a single-acting unit and operates in two duties.

At the 30-kg effort applied to the handle end and at 15 double strokes per minute, the pump gives outputs:

(a) about 2 lit./min. while using the 50-mm piston at a working pressure of 10 kgf/sq.cm;

(b) about 0.33 lit./min. while using the 20-mm piston at a working pressure of 50 kgf/sq.cm. With increase in effort applied to the handle up to 60 kg, the pump can build up a pressure to about 125 kgf/sq.cm.

Pump casing 293 is a cast cylindrical structure with lugs for securing it to the foundation. The cast cover closing the casing at the top has a brass bush inside which runs guide steel rod 288.

Thread-connected to guide rod 288 is high-pressure rod-piston 290, 20 mm in dia. To gain the greater output at a lower pressure, rod-piston 292, 50 mm in dia., is meshed with guide rod 288 with the aid of piston grip 289 which is turned by the handle. The handle is stopped by lock 294 when the pump operates with the rod-piston of the smaller diameter.

Screwed into the pump casing is valve chest 281 with suction and pressure non-return valves.

Needle plug 291 serves to vent air out of the pump when the system is charged with oil.

Plugs, connections and the valve chest are sealed with copper gaskets.

Handle 285 is detachable. It is stored near the pump.

CUT-OFF VALVE

40. The cut-off valve (see Dwg.11) is installed to protect the air-hydraulic accumulators from discharging and to cut off the pumping plant from the pressure main in case of the pressure piping failure.

Disc 316 is located in valve housing 315. In the open position it is pressed by spring 317 against a bead of rod 318. The rod passes through cover 328. It is sealed with rubber rings 327 and fixed by balls 320 which are tightened by springs 321. Screwed on the cover connection is air cylinder 326 with piston 325 and rubber packing rings 324. The cylinder is held from turning with the aid of locking washer 322.

Spring 317 is adjusted by turning the rod with a hexahedron on the end for a wrench. Disc 316 is held from turning with the aid of key 319, and the rod with the aid of locking strap 323.

Should the piping burst, the oil flow rate will increase, and a pressure drop will result at the disc. The disc compresses spring 317 and seats on the valve seat.

To close the cut-off valve by force, the intermediate pressure air is delivered to air cylinder 326. Piston 325 moves rod 318 together with disc 316 until it seats on the valve seat.

To return the disc to its initial position, equalize the oil pressure on both sides of the disc.

In case the cut-off valve has been force-closed, release pressure in the air cylinder, and the disc will return to its initial position under the action of the oil pressure.

BY-PASS SLIDE-TYPE COCK

The by-pass slide-type cock (see Dwg.12) serves to disconnect the operating mechanism from the hydraulic system and to communicate its chambers with each other when the mechanism is operated by hand.

41. Slide-valve 332 turns in bush 334. The slide-valve is lapped by the bush. It has inner bores to pass oil. Fitted on the slide-valve end is handle 336 which is fixed by ball 338 in two positions HYDRAULICS (ГИДРАВЛИКА) and BY-PASS (ПЕРЕПУСК).

The bush and the slide-valve are sealed with rubber rings.

Four connections are screwed in the slide-valve housing. The drawing shows HYDRAULICS position.

With the handle moved to BY-PASS, connections FROM CONTROL VALVE (ОТ МАНЕВРОВОГО КРАНА) are disconnected from the mechanism, and connections TO OPERATING MECHANISM (К ИСПОЛНИТЕЛЬНОМУ МЕХАНИЗМУ) are connected with each other with the aid of a groove provided in the slide-valve.

BY-PASS SLIDE-VALVE

The by-pass slide-valve (see Dwg.13) is provided for use in the event of failure of the pumps electric interlocking system (i.e., with the air-hydraulic accumulators charged the pumps do not start up).

42. The slide valve consists of housing 347 with press-fitted bush 348. The bush laps slide-valve 349.

The slide-valve rests against bush 350 supported by spring 351 adjusted to a popping pressure of 110±3 kgf/sq.cm.

The spring is adjusted with the aid of adjusting bush 352. Screwed in the slide-valve housing is plug 345 sealed with gasket 346.

Should the pressure in the pressure main rise, the slide-valve will compress the spring and move up to communicate the pressure main with the pump by-pass slide-valve. The pump changes over to idle running. But as soon as the pressure in the pressure main drops below 110 kgf/sq.cm, the spring shifts the slide-valve to its initial position, the pressure from the pump by-pass slide-valve will be forced to the drain main, and the pump will change over for normal operation.

FILTERS

The screen-disc type filters (see Dwgs.14 and 18) serve for cleaning oil flowing to the operating mechanism and oil drained to the service tank.

43. The twin filter is installed ahead of the tank and allows to clean filter elements in turn without stopping the system. It includes two filter elements mounted on a common casing. A cock arranged in the casing serves to change over the operating filter.

The filter elements employ screen with a mesh of 0.063x0.063 mm in the clear.

Plugs are provided to vent air when filling the filter.

44. The single filter (see Dwg.14) has filter cartridge 357 with disc-type elements having a mesh of 0.025x0.025 in the clear.

The filter cartridge is installed in casing 356, [illegible] 358 is screwed in the housing. Plug 360 is arranged in the cover to vent air from the filter.

AIR FLASK

The air flask (see Dwg.15) with compressed air serves for keeping constant a working pressure in the hydraulic system.

45. Steel seamless flask 372 is fixed on a rigid [illegible] tion. When the flask is installed, it should be inclined in the direction of the neck. Screwed into the neck is head 371 with two valves. To blow the flask a pipe is welded into one of the above valves. The pipe should be lowered down; its position is fixed against a notch on head 371.

The other groove serves for air to pass to the air-hydraulic accumulators.

OIL COOLER

The oil cooler (see Dwg.16) is installed on the drain pipe line and is used for cleaning oil delivered into the tank.

46. The oil cooler consists of casing 378, heat exchanging pipes 381, two pipe boards 383 and two covers 375 and 385.

The pipe boards have plugs 382, lower plugs for draining oil, and upper plugs, for bleeding air when filling the oil cooler. Plug 379 also serves for draining oil.

Diaphragms 380 are installed in the oil cooler to vary the direction of the oil flow. Ends of pipes 381 are welded to the pipe boards.

The covers are fastened to the casing by means of pins.

The sockets arranged in the covers serve to receive zinc protectors 376 and 386 designed for anticorrosive protection of the oil cooler components coming in contact with cooling water.

To drain cooling water from the covers, use is made of plugs 384. All the joints of the oil cooler are sealed with paronite gaskets.

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3. CONTROL AND MEASURING INSTRUMENTS

Table 1

No.	Ref. in schematic diagram	Name and application	Normal value / Limiting value (red line)	Location	Remarks
1	2	3	4	5	6
1	59, 70, 73, 89a, 97, 110, 130	Gauge MTK 100Bx160/100, accuracy grade 2.5 to read pressure in piping	100/160 kgf/sq.cm	On pressure pipes at operating mechanisms; on air piping to air-hydraulic accumulators; at motor-driven pumps	
2	60, 69, 89b, 131	Gauge MTK 100Bx60/25, accuracy grade 2.5 to read pressure in drain piping	25/60 kgf/sq.cm	On drain pipes	
3	50, 117	Gauge MTK 100Bx10/7.5, accuracy grade 2.5 to read pressure in drain piping ahead filters	7.5/10 kgf/sq.cm	On drain pipes ahead of oil tanks	
4	121	Gauge MTK 100Bx1/0.5,	1/0.5 kgf/sq.cm	On drainage pipe in	

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1	2	3	4	5	6
		accuracy grade 2.5 to read pressure in drainage piping ahead filter		conning lower	
5	-	Pressure vacuum gauge MTK 100Bx700-1, accuracy grade 2.5 to read vacuum in suction chamber of motor-driven pumps	760-0-1	On suction chamber of motor-driven pumps	
6	56	Temperature gauge KT-100 to read oil temperature in drain main	0° to 100°C	Near service tank on drain pipe	
7	-	Temperature gauge TC-4 to read oil temperature in service tank	0° to 100°C	On service tank	
8	-	Ammeter M-180 to read current	0 to 75 A	Near motor-driven pumps	

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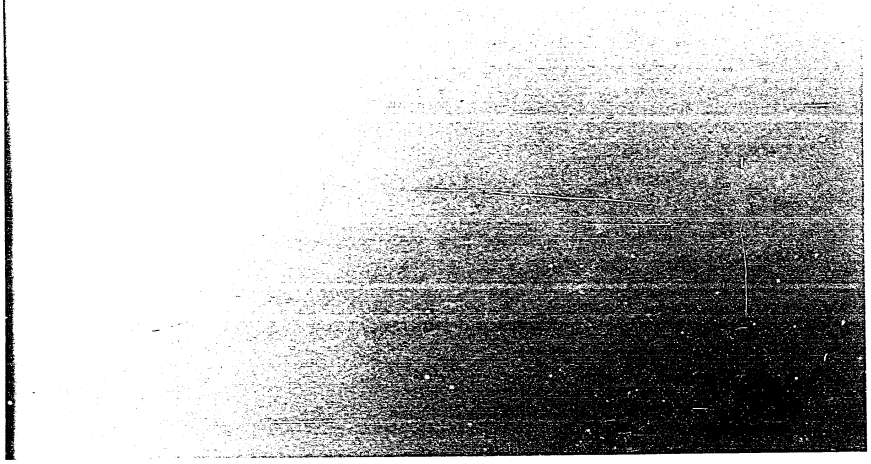
E. ADJUSTABLE FITTINGS

Table 2

No.	Description	Ref. in schematic diagram	Adjustment pressure, kgf/sq.cm	Remarks
1	Back pressure valve	53, 115	2	
2	Safety valves on piping to masts of night altiscope ПЗНТ-8 and attack periscope ПК-8.5	118, 119	105	
3	Safety valve on reducing valve	75	110	
4	Cut-off valve	99	-	see Item 148
5	By-pass slide-valve	62, 95	1104.3	



III. MAINTENANCE INSTRUCTIONS

A. GENERAL SUPERVISION AND CARE

UPKEEP

47. The motor-driven pumps of the hydraulic system should be employed in compliance with the operating instructions for motor-driven pumps 3NH1.25/100.

The electrical equipment should be employed in accordance with the operating instructions on electric motors and apparatuses included with the set of the system.

The operating mechanisms should be employed in conformity with their operating instructions.

48. During service keep the system clean and serviceable, check fittings for reliable attachment of the pipings to the casing structures, take measures to protect the system components against impact and distortion.

49. While operating the hydraulic system:

- keep it in sound condition and in constant readiness for action;
- check the pipings and fittings for tightness, paying particular attention to pipe unions and flexible hoses. Eliminate oil leakage and wipe off traces of oil;
- open valves on the pipings under pressure gradually;
- see that name plates of the fittings are intact;
- timely repaint the pipings, the indicators of direction of rotation of valves and r.p.m. counters.

50. Keep all the gauges and safety valves in sound repair and sealed.

51. Pour and add oil into the hydraulic system through silk cloth only.

52. Check the system for air pressure against gauge. The air pressure should be 100 kgf/sq.cm. with the air-hydraulic accumulators completely charged, and 72.5 kgf/ with the main air-hydraulic accumulators completely charged.

53. Make certain the oil temperature in the system does not exceed +30°C. ?

54. Check the service tank for oil level. With the air-hydraulic accumulators charged and the masts lowered, the volume of oil in the service tank should be equal to 145 litres. Should the oil level be below the above amount, locate the cause of leakage and correct the trouble.

55. Watch the signalling boards to be certain that the pumps are switched on and off in accordance with the selected operating duty.

56. Prior to turning over the mechanisms, drain sediment from the service tank through cock 39. When turning over the mechanisms, watch the light signalling to check the pumps for automatic operation.

57. Watch the ammeters to check load of the motor-driven pumps.

58. Check the electric pumps for operating hours, and regularly change over universal switch $УП_2$ to the other position (employ the pumps in reserve duty in succession).

B. PUTTING HYDRAULIC SYSTEM INTO OPERATION, DURING-OPERATION SERVICING AND STOPPING

The hydraulic system ready for starting should be in the initial condition.

INITIAL CONDITION

59. In its initial condition the hydraulic system is charged with oil, the air-hydraulic accumulators being charged are under pressure, and cut off from the system by valve 109. The service tank should be filled with oil to the 145-litre mark, and the remaining tanks to the upper mark on the level gauge.

The pressure in the pressure line should be relieved via valve 100, whereupon the valve should be closed.

The pressure in the air piping and cylinders should be 100 kgf/sq.cm against pressure gauge 97.

WARNING: Never relieve pressure in the system with valve 109 open.

60. The handles of the control valves of all the operating mechanisms should be put in a position corresponding to the initial position of the given mechanisms.

61. The following valves should be open:

(a) valves 22, 23, 24, 25, 27, 29, 30, 31, 32, 33, 34, 35, 61 and 63 at the motor-driven pumps;

(b) valves 109, 105 and 106 at the air-hydraulic accumulators;

(c) valves 74, 101, 104 and 108 on the high-pressure air piping;

(d) valve 38 on the suction piping;

(e) valve 52 on the drain piping;

(f) valves 120, 122 and 123 to the hoists of night altiscope ПЗНГ-8 and attack periscope ПК-8.5;

(g) valves 43 and 44 at the by-pass valve of the stern plane tilt ram;

(h) valve 51 on the drain piping.

62. The following valves should be sealed in the open position:

(a) valves 64, 65, 66, 76, 77, 78, 126, 127, 128, 129 on the pressure and drain mains and on the drainage piping;

(b) valves 68 and 83 at the control valve groups on the drain pipes;

(c) back pressure valve 53 on the drain piping.

63. The following valves should be sealed in the closed position:

(a) valves 37, 54, 87 and 136 cutting off the pressure line from the drain main, and the drain main from the suction main;

(b) valve 28 at the reserve tank;

(c) two-way control valve 111 for air delivery to the cut-off valve;

(d) valve 107 to bleed air from the air-hydraulic accumulators.

64. Set to the NO RETURN (НЕВОЗВРАТ) position and seal screw-down non-return valves 12 and 102 at the air-hydraulic accumulators.

65. Set to the HYDRAULIC position and seal all the by-pass slide-type valves.

66. Set all the remaining valves and cocks to CLOSED.

67. Set the handle of universal switch УП$_1$ to OFF.

68. Set the handle of universal switch УП$_2$ to the position in compliance with Item 58.

69. Set packet switches ПП$_1$ and ПП$_4$ to OFF.

70. Set packet switches ПП$_2$ and ПП$_3$ to MAIN AND RESERVE PUMPS.

71. Cut out the packet switches supplying power to the pump control stations and signalling boards.

PREPARING THE SYSTEM FOR OPERATION

To prepare the system for operation, perform the following operations:

72. Clean filter elements of the filters before the control valve groups.

73. Check the oil level in the service tank and drain sediment from the sump via cock 39. Check also for absence of water in the oil chamber of the oil cooler by opening the drain plugs.

74. By closing valve 74 and blowing the air flask through valve 71, make sure that oil is absent. If oil is detected, look for the cause of oil ingress and eliminate the trouble. Blowing over, add air into the system till the pressure is 100 kgf/sq.cm.

75. Check all the valves and cocks for opening and closing following the procedure described in Section "Initial Condition", and open valve 107.

Note: Stop valves [illegible] when preparing [illegible] tion.

76. Prior to starting the motor-driven pumps, do the following:

(a) check insulation resistance of the electric motors which should be not less than 0.5 megohm;

(b) turn-over the electric pumps by hand;

(c) cut in the signalling power supply switch in compartment III;

(d) check the motor-driven pumps for proper operation when starting them with the aid of the START button. To this end, put universal switch $УП_1$ to MANUAL CONTROL. Cut in the packet switch supplying voltage to the input terminals and to the electric motor. Depress the START button of the respective pump.

Depress the STOP button to stop the motor-driven pump.

77. Make sure that the motor-driven pumps start and stop automatically. To this end, prepare the automatic system for operation in one of the duties in compliance with Items 27 and 58.

Completely discharge the air-hydraulic accumulators with the aid of valve 100. During the discharge, check the signalling system for proper operation, and the pumps for automatic starting in accordance with the preset duty of operation.

Close the by-pass valve and make certain that the pumps are stopped automatically.

Check the pumps for operation in the other duties including the emergency pump operation, following the same procedure.

The last check should correspond to the selected automatic operating duty of the hydraulic system electric pumps. Before putting the system into operation, put universal switch $УП_1$ to OFF.

78. Visually inspect the gauges for proper condition.

79. Before every cruise, open valves 88 and 89 disconnecting the submerging system, valves 13, 14, 17 and 18 disconnecting the plane tilting rams, and valve 112 shutting off the two-way control valve.

PUTTING THE HYDRAULIC SYSTEM INTO OPERATION.
DURING-OPERATION SERVICING.
STOPPING THE SYSTEM

80. To put the hydraulic system into operation, put universal switch VII_1 to AUTOMATIC CONTROL.

When servicing the hydraulic system, take the following steps:

81. Watch the oil temperature in the system against temperature gauge 56 installed on the drain line. With the oil temperature rise above +25°C, engage the oil cooler. To this end, open valves 47, 47a, 48, 49 and close valve 52. Amount of cooling water entering the oil cooler is governed by valve 47 or 47a. With the oil temperature drop down to +15°C, disconnect the oil cooler, open valve 52 and close valves 47, 47a, 48 and 49.

82. Watch the oil level in the service tank. Never start the electric pumps if the oil level has dropped down to 105 litres with the air-hydraulic accumulators charged and the masts lowered.

83. See that the motor-driven pumps, electrical equipment and operating mechanisms operate properly in compliance with their appropriate maintenance instructions and the present instructions.

MAINTENANCE IN EMERGENCY

84. On operation of cut-off valve 99, localise the oil leakage from the piping and shut off the damaged section of the piping from the pressure line. The cut-off valve operation is indicated by pressure gauge 91a in the absence of pressure and by pressure gauge 110 in the presence of pressure.

To make the hydraulic system operate upon shutting off the damaged section of the piping, set the cut-off valve to its initial position. To this end, open valve 98 on the [illegible] pipe. With the cut-off valve set to the initial position (pressure read by pressure gauge [illegible]) close valve 96 and then seal it.

85. On reporting from any compartment oil leakage (torn gasket, crack in a pipe) to which cut-off valve 99 has not responded, force it to close by turning the handle of two-way control valve 111. The trouble eliminated put the control valve handle to OPEN, and open valve 98 for a short time.

86. If the electric remote control of the electromagnetic control valves fails, manipulate them by hand. In this case deenergize the electromagnets.

87. Should the air-hydraulic accumulators malfunction, follow Table 3. In so doing, automatically stop the pumps, set the upper limit switch (I_t, II_t or III_{t_1}) of the faulty air-hydraulic accumulator in the position corresponding to the charged air-hydraulic accumulator (depress the roller on the limit switch till the click is heard). Then lock it in this position by putting a wedge under the switch roller or by some other means. The lamp indicating the charge of the air-hydraulic accumulator should light up.

88. If the electric control system is out of order, start and stop the motor-driven pumps with the aid of buttons START and STOP. In this case universal switch VII_1 or packet switch III_4 should be set to MANUAL CONTROL. Start the pumps under a pressure of 80 kgf/sq.cm and stop the last of the pumps when the pressure is 98 kgf/sq.cm.

89. Should one of the pumps No.1, No.2 and No.3 fail to operate, shut off it by valves, deenergize it, and proceed with operation using the remaining two pumps. Universal switch VII_2 should be placed at the position corresponding to the change-over of the faulty pump to reserve.

If two motor-driven pumps fail to operate, disconnect them and perform operation with one motor-driven pump which should be started upon discharge of air-hydraulic accumulator No.1.

90. In case of failure of all the motor-driven pumps the service tank located in compartment VII, disconnect [illegible] and start the emergency pump in compartment III. For this purpose:

(a) drain sediment through cock 114;

Position of Pumping Plant Controls in Emergency

Table 3

Faulty mechanism	Valves		Switches						Additional operations
	to open	to close	УП$_1$	УП$_2$	ПП$_1$	ПП$_2$	ПП$_3$	ПП$_4$	
1	2	3	4	5	6	7	8	9	10
			Main Pumps and Reserve Pump Operating						
Air-hydraulic accumulator No.1	12	106,108, 109	Automatic control	Any	OFF	Main and reserve pumps	Main and reserve pumps	OFF	Deenergize one of main pumps
Air-hydraulic accumulator No.2	103	12,104, 105,106	Automatic control	Any	Main and reserve pumps	OFF	Main and reserve pumps	OFF	Deenergize one of main pumps
Air-hydraulic accumulator No.3	-	101,102, 105	Automatic control	Any	OFF	Main and reserve pumps	Main and reserve pumps	OFF	Deenergize reserve pump
Air-hydraulic accumulators, No.1 and No.2	102	12,104, 105,106, 108,109	Manual control	Any	OFF	OFF	OFF	OFF	Control pumps by hand
Air-hydraulic accumulators, No.1 and No.3	12	101,102, 105,106, 108,109	Manual control	Any	OFF	OFF	OFF	OFF	Control pumps by hand

1	2	3	4	5	6	7	8	9	10
Air-hydraulic accumulators No.2 and No.3	-	12,101, 102,104, 105,106	Manual control	Any	OFF	OFF	OFF	OFF	Control pumps by hand
			Emergency Pump Operating						
Air-hydraulic accumulator No.1	12	106,107, 109	OFF	Any	OFF	Emer-gency pump	Emer-gency pump	Auto-matic control	
Air-hydraulic accumulator No.2	102	12,104, 105,106	OFF	Any	Emer-gency pump	OFF	Emer-gency pump	Auto-matic control	
Air-hydraulic accumulator No.3	-	101,102, 105	OFF	Any	Emer-gency pump	OFF	Emer-gency pump	Auto-matic control	
Air-hydraulic accumulators No.1 and No.3	12	101,102, 105,106, 108,109	OFF	Any	OFF	OFF	OFF	Manual control	Control pump by hand
Air-hydraulic accumulators No.2 and No.3	102	12,104, 105,106, 108,109	OFF	Any	OFF	OFF	OFF	Manual control	Control pump by hand
			OFF	Any	OFF	OFF	OFF	Manual control	Control pump by hand

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SECRET

SECRET

No.2 and No.3 | 1105.106 |

1	2	3	4	5	6	7	8	9	10
			Main Pumps Operating						
Pump No.1	-	32,33, 34,35	Auto-matic con'rol	Pump No.1 is reserve	OFF	Main and reserve pumps	Main and reserve pumps	OFF	Deenergize pump No.1
Pump No.2	-	27,29, 30,31	Auto-matic control	Pump No.2 is reserve	OFF	Main and reserve pumps	Main and réserve pumps	OFF	Deenergize pump No.2
Pump No.3	-	22,23, 24,25	Auto-matic control	Pump No.3 is reserve	OFF	Main and reserve pumps	Main and reserve pumps	OFF	Deenergize pump No.3

SECRET

SECRET

(b) open valves 90, 91, 92, 93, 94, 96, 113 and 115;
(c) set packet switch III_4 to AUTOMATIC CONTROL;
(d) set packet switches III_3 and III_1 to EMERGENCY PUMP (АВАРИЙНЫЙ НАСОС);
(e) set packet switch III_2 to OFF;
(f) close the packet switch supplying power to the emergency pump motor.

WARNING. When using the emergency pump keep not more than three masts hoisted at a time in view of small capacity of the emergency tank.

91. If the pressure or drain main is damaged in compartment I or II, shut valves 128 and 129.

Operate the torpedo tube muzzle doors with the aid of hand-operated drives.

92. If the pressure or drain main is damaged in compartment III, shut valves 76, 77, 126 and 127, actuate the operating mechanisms (except masts) with the aid of hand-operated or electric-operated drives.

93. If the pressure or drain main is damaged in compartment IV, V or VI, shut valves 65, 66, 76 and 77.

Use the hand-operated drives to actuate the operating mechanisms the control valves of which are installed in compartment V.

To operate the other mechanisms, start the emergency pump in compartment III (see Item 90).

94. If the pressure or drain main is damaged in compartment VII, shut valves 65 and 66.

To actuate the operating mechanisms, start the emergency pump in compartment III (see Item 90).

MAINTENANCE IN CASE OF FIRE HAZARD

95. In case of fire hazard when the submarine is in the base, follow the procedure below:

(a) immediately lower all the masts, which are in the UP position;

(b) relieve pressure from the pressure main. To do this shut valve 109 and open valve 37 or 100.

96. Deenergize the pumps and the signalling system.

STOPPING THE SYSTEM

97. Shift the system into its initial position (see Items 59-70).

98. Cut out the switch supplying power to the signalling boards.

99. Set to the OFF position the packet switches supplying power to the motor-driven pumps.

C. MAINTENANCE AT LONG-TERM STANDSTILL

100. The long-term standstill of the submarine means putting the submarine to running or medium repairs or relegating to reserve.

Note: At long-term standstill the operating mechanisms powered by the hydraulic system are serviced in compliance with the appropriate instructions.

When putting the submarine to repairs, perform the following procedure:

101. Examine the motor-driven and hand pumps and the control valves. Test them in operation.

102. Drain oil from the system (see Section "Draining the System"), flush the system (see Section "Flushing the System") and fill it with oil (see Section "Filling the System with Oil").

103. Disassemble the air-hydraulic accumulators, clean the inner chambers and fill them with oil.

104. Fill all the oil tanks with oil up to the upper mark on the level gauge.

105. Blow the high-and-intermediate pressure air piping and the air flask with dry [illegible] air; charge air in the flask under a pressure of 5 [illegible]

106. Disassemble and [illegible] the hydraulic system if [illegible]

Place the control valve handles to the middle position and lock them.

107. Clean the outer unpainted surfaces of the fittings and then coat them with gun grease.

Renew varnish and paint coating.

When putting the submarine into operation after repairs, do the following:

108. Remove grease from outer surfaces of the fittings with cotton cloth soaked in diesel fuel. The valves should be worked. Hard-to-turn valves should be overhauled, the safety valves should be overhauled, adjusted and sealed.

109. Thoroughly examine motor-driven pumps, eliminate troubles, turn over pumps by hand, prepare and start them in compliance with the appropriate maintenance instructions.

110. Open air-hydraulic accumulators, drain oil, inspect inner surfaces and packing rings for proper condition, and eliminate traces of corrosion. Reassemble the air-hydraulic accumulators and fill them with oil.

111. Drain oil from the system (see Section "Draining the System"), flush the system (see Section "Flushing the System"), fill it with oil (see Section "Filling the System with Oil"), then test the system for tightness (see Section "Testing the System for Tightness").

112. Turn over all the operating mechanisms by hand, and then turn them over several times with the aid of hydraulic system.

5

50X1-HUM

Table 4

D. TROUBLES AND REMEDIES

No.	Symptoms	Cause	Remedy
1	2	3	4
1	Motor-driven pumps start and stop but not in compliance with preset operating duty	Faulty automatic control circuit of motor-driven pumps	Change over motor-driven pumps to manual control, locate and correct trouble
2	Reserve and main motor-driven pumps switch on simultaneously	Valves 12 and 102 are not set to NO RETURN	Set valves 12 and 102 to NO RETURN
3	Oil leaks through seal of contactor drive shafts on upper and lower covers of air-hydraulic accumulators	Faulty packing rings of drive shafts or faulty celluloid washers	Replace packing rings on shafts or replace washers (see Dwgs.1 and 2)
4	With piping in proper condition pressure in pressure main drops below lower limit. With operating mechanisms rarely switched on, electric pumps work for long time	Faulty or partially closed valves 54, 100 and 136 communicating pressure and drain mains	Close valves or correct trouble
5	Cut-off valve operates during work of vent valve hydraulic mechanisms	Maladjusted throttles before control valves of hydraulic mechanisms	Adjust throttles to operate 2-4 seconds before work of vent valve hydraulic mechanisms

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1	2	3	4
6	Oil leaks through rods of valves and control valves	Faulty or loose seals of rods of valves and control valves	Replace packing rings or tighten gland packings
7	Abrupt pressure drop in pressure piping in the presence of pressure before cut-off valve as read by gauge 110	Cut-off valve has operated due to damage to pressure piping	Find and eliminate trouble in pressure piping and then perform operations of Item 84
8	Presence of oil in air when air flask is being blown	Poor sealing of air-hydraulic accumulator rod	Disconnect air-hydraulic accumulator from hydraulic system, inspect packing rings. Replace faulty packing rings
9	Water is detected in oil chamber of oil cooler while draining sediment	Poor sealing of water chamber	Test oil cooler for tightness. Correct trouble. Plug faulty pi

E. PREVENTIVE INSPECTIONS AND REPAIRS

113. Preventive inspections and repairs are [illegible] and serve to:

(a) prevent premature wear of the hydraulic [illegible]

(b) timely locate troubles and defects in the hydraulic system and eliminate them.

114. Immediately eliminate troubles located in the course of service of the system. Never operate the system.

115. Preventive inspections and repairs are subdivided into daily, weekly, monthly and other types of inspections and repairs depending on nature and volume of work to be carried out.

116. When the submarine is put to medium or running repair, the hydraulic system should be inspected at the same periods as under service conditions.

117. All the control and measuring instruments should be sealed. Check them at specified intervals. Never use the incorrect-reading instruments and instruments with broken sealing and protective glass.

Preventive inspections and repairs of the electrical equipment should be performed in compliance with the appropriate maintenance instructions on individual items of electrical equipment, on 175-320-V D.C. power distribution mains and on shipboard signalling system.

When performing the preventive inspections and repairs, take the following steps:

Daily Inspection

118. Visually inspect and clean pipings, fittings, control and measuring instruments, motor-driven pumps and air-hydraulic accumulators.

119. Visually inspect condition of control and measuring instruments of motor-driven pumps, make sure that seals on instruments are present.

120. Check oil level in the service tank, drain sediment.

121. Blow the air flask and add air up to a pressure of 100 kgf/sq.cm with the air-hydraulic accumulators charged.

122. Test by hand all operating mechanisms equipped with hand-operated drives, except for hydraulic mechanisms of sea cocks and vent valves.

123. Give the motor-driven pumps 2-3 turns by hand and make sure that they are free of seizing.

124. Prepare and start the motor-driven pumps in compliance with the pump maintenance instructions. Test over all the operating mechanisms with the exception of the [illegible], the hydraulic mechanisms of sea cocks and vent valves.

125. Check performance of motor-driven pumps in operation. Make sure that the signalling system and automatic switching on/off system of the pumps are serviceable.

126. Check for absence of water leak through cocks of the drainage pipes of the hydraulic cylinders of torpedo tube muzzle door drives.

127. Turn over all the hydraulic system valves and cocks, except the sealed ones. Work or overhaul the hard-to-turn valves.

Weekly Inspection

Perform all the daily inspection operations and in addition do the following:

128. Check proper operation of safety by-pass valve in valve unit of motor-driven pumps by twofold-threefold opening and closing of the stop non-return valve on pressure line of each pump. The pressure gauge of the pump shall read a pressure within 110 to 115 kgf/sq.cm.

129. Relieve pressure from air chambers of the air-hydraulic accumulators, and fill the top chamber with oil pouring it through plug holes on the top cover. In this case the pistons should be in the upper position.

130. Carefully inspect all joints and fittings. Tighten the joints and seals of the valves if necessary. Before doing this, relieve pressure.

131. Examine and check performance of hand pumps in operation.

132. Turn over electrically and manually operated control valves.

Monthly Inspection

Perform all the weekly inspection operations and in addition:

133. See that motor-driven pumps and air-hydraulic accumulators are properly fastened to the foundation. Check condition of shock absorbers.

134. Check condition of mechanical gland and rubber pins of sleeve. Eliminate leaks in the pump pipe unions.

135. Make analysis of oil. If the oil contains over 0.1 per cent water and over 0.03 per cent solid matter, replace it.

Repeat the analysis of oil upon return from the cruise. Take oil samples through valve 40.

136. Clean filters before service tank. Clean the filters every 50 operating hours.

137. Check performance of by-pass slide-valve 62 in operation.

To do this, close the packet switch in the motor-driven pump power supply circuit, set universal switch VII_1 to MANUAL CONTROL and depress the START button on the control station. The pressure in the system increasing up to 110±3 kgf/sq.cm, the by-pass slide-valve must operate to change over the pump to idle work.

138. Check performance of safety valve and slide-valves in compliance with Table 2 given in Section E.

Quarterly Inspection

Perform all the monthly inspection operations and besides:

139. Turn over all sealed fittings and seal them anew.

140. Clean all filters installed in the system.

141. Examine protectors on covers of oil cooler water chambers.

Replace protectors worn to and over 50 per cent. Insure reliable contact of protector with the oil cooler cover. Remove dirt and corrosion traces during every inspection of the protectors.

142. Check all operating mechanisms for smooth action. To do this, employ the [illegible] and other mechanisms at all duties.

The mechanisms should work smoothly, without jerks, noises and knocks. [illegible] ning to the [illegible] adjust work of the [illegible]

the response time is specified in the appropriate instructions.

Half-Yearly Inspection

Perform all inspection operations pertaining to the quarterly routine, and besides:

143. Inspect footstep bearings of motor-driven pumps. If oil grooves are worn out or absent, repair or replace the bearings.

144. Check output by noting the time taken by each pump to charge accumulators No.1 and No.2.

For this purpose, close valves at the pumps except the pump to be tested, and close valves 102, 103, 105 at air-hydraulic accumulators. Discharge the air-hydraulic accumulators through valves 100 and 109 and then close valve 109. Start the pump. The time of charging the accumulators must be about 6 minutes.

145. Check the system for internal oil-transfer. Perform the check by pressure gauge 59. With the air-hydraulic accumulators completely charged, pumps disconnected, and valves before control valves open (except valve 4 cutting out the pressure to the hydraulic motor turning night altiscope ПЗНГ-8), the tolerable pressure drop in the pressure line is from 100 to 95 kgf/sq.cm within 2 hours.

Yearly Inspection

Perform all the inspection operations pertaining to half-yearly routine, and then:

146. Visually inspect all rubber packings for tightness and check flexible inserts (hoses) for condition, and, where necessary, replace.

Replace rubber packing rings of pistons of the air-hydraulic accumulators.

Note: During running repair replace rubber packings and hoses if they are not sound or if their service period has expired.

The service period of rubber packings is 5 years

and a storage period before their installation on the ship is 2 years (the storage period may be extended to over 2 years, but in this case the service period will be subsequently shortened to make the total period of storage and service within 7 years).

The service period of rubber hoses is 2 years, a storage period is one year (the storage period may be over 1 year, but in this case the service period will be subsequently shortened to make the total period of storage and service within 3 years).

147. Examine pressure gauges and pressure vacuum gauges.

148. Check to see that cut-off valve 99 is so adjusted, that it works whenever the oil flow rate increases.

Perform the check as follows:

(a) Charge the air-hydraulic accumulators and open valves 98 and 100. Then open valve 109 so as to insure discharge of air-hydraulic accumulator No.1 within 10 seconds that corresponds to oil consumption at the rate of 6 lit/sec. (the discharge time is registered by a stopwatch). The beginning and the end of discharge are indicated by signal lamps. Lamp MAIN AIR-HYDRAULIC ACCUMULATOR No.1 CHARGED (1 ОСНОВНОЙ ГИДРОАККУМУЛЯТОР ЗАРЯЖЕН) goes out to indicate the beginning of discharging. Lamp MAIN AIR-HYDRAULIC ACCUMULATOR No.2 CHARGED (2 ОСНОВНОЙ ГИДРОАККУМУЛЯТОР ЗАРЯЖЕН) goes out to indicate the end of discharging.

Having provided necessary time for discharge, close valves 98 and 100 and completely charge the air-hydraulic accumulators. Upon completion of charging the air-hydraulic accumulators open valve 100. The cut-off valve should come into action. If the valve has failed to operate, turn rod 318 to lessen effort of spring 317 (see Dwg.11).

(b) Open valve 109 so as to insure discharge of an air-hydraulic accumulator within 11 seconds that corresponds to oil consumption at the rate of 5.5 lit/sec. Charge the air-hydraulic accumulators and open valve 100. The cut-off valve should not work. Repeat the check three times.

149. Check cut-off valve for [illegible] supply intermediate pressure air through [illegible] valve 11 to the air cylinder of the valve. The [illegible] work is determined by ear.

Perform the check 3 times with a pressure in the [illegible] being equal to 100 kgf/sq.cm.

150. Flush hydraulic system pipings (see Section "Flushing the System").

151. Test hydraulic system pipings for tightness (see Section "Testing the System for Tightness").

Inspection During Routine Repair

152. Open manholes of oil tanks, inspect, and, where necessary, clean and flush inner cavities.

WARNING. 1. When replacing paronite gaskets, see that they are made of paronite YB-10. Never use paronite gaskets of any other grade in joints of the hydraulic system.

2. It is prohibited:

(a) to install rubber collars with scratches, notches and other defects, as well as to correct these defects by filling;

(b) to install improvised (non-standard) rubber packing rings manufactured on machine tools by manual filing, etc.;

(c) to use cutting tools to position rubber packings and to fit them into their seats.

F. FILLING, DRAINING AND FLUSHING THE SYSTEM

FILLING SYSTEM WITH OIL

153. The newly installed and flushed or drained system must be filled with spindle oil, grade AY.

Prior to filling the system, do the following:

(a) test hydraulic mechanisms and masts for locking;

(b) see that the system is filled with the proper grade of oil as indicated in the Certificate;

(c) prior to attaching oil charge and discharge hose 57 to the piping, thoroughly flush inside of the hose with oil heated up to 60 - 70°C;

(d) check to see that inner surfaces are clean in all oil tanks;

(e) close all valves and cocks of the system.

Deliver oil with one of motor-driven pumps mounted in compartment VII by opening valves communicating this pump with the system and valves 61 and 63 at the by-pass slide-valve.

Fill the system in the following sequence:

Filling Service Tank

154. Open valve 38 and turn back flange joint at suction connection of the motor-driven pump. Remove plug 36, connect hose to the suction line, and pour oil into the hose from the deck. As soon as oil appears in the service tank and at the pump connection, stop filling, close valve 38, and tighten the pipe union.

Open valves 52, 53, 54, cock 51, prepare the motor-driven pump and start it for filling the tank with oil from a reservoir on deck. After the service tank is filled up to the upper mark on the level gauge, stop the pump. As oil is consumed, replenish the service tank with oil when filling the system.

Filling Spare Tank

155. Open valves 28 and 38, and fill the spare tank up to the upper mark on the level gauge with oil flown by gravity from the service tank. The filling over, close valve 28.

Filling Reserve Tank

156. Open valves 65, 77, 115, cock 116 and start the pump. Fill the tank up to the upper mark on the level gauge, then stop the pump and close valve 115.

Filling 35-litre Tank

157. Open valves 85, 86 and start the pump. Fill the tank up to the upper mark on the level gauge. Then stop the pump and close valve 85.

Filling Pressure and Drain Pipe Lines

158. Close valve 54, open valves 48, 49, 66, 76, 126, 127, 128, 129, 136 and start the pump. Prime the pressure and drain pipe lines with oil until the air is forced out from them. Stop the pump and close valves 48 and 49.

Using the emergency pump of compartment III, prime the pipe lines. Open valves 91, 113 and back out the pipe union at the pump suction connection. Tighten the pipe union as soon as oil appears near the suction connection. Open valves 90, 92, 93, 94, 96, 98, 115 and start the pump. Having primed the pipe lines, stop the pump and close valve 136.

Filling the Stern Plane Tilting Ram and Evacuating Air from Pipes 45

159. Open valves 18, 43, 44, place the handle of the tilting ram control valve in compartment III at one of the end positions, and open needle plugs to bleed air from the both chambers of the ram. Start the pump of compartment VII. When the oil appears through the plug, stop the pump and tighten the plug. Shift the control valve handle to the other end position thus filling the other chamber of the tilting ram.

After filling the ram employ the hand pump of compartment VII to evacuate air from pipes 45.

For this purpose, open valves 21 and 26, back out pipe unions on pipes 45 at the safety slide-valve through 2 - 3 turns, place the control valve handle at one of the end positions and employ the hand pump. As oil appears tighten

the union, set the control valve handle to the other end position and continue to operate the hand pump.

With the tilting ram filled and air evacuated, move the control valve handle to the middle position and close valve 18.

Filling Vertical Rudder Ram
and Evacuating Air from Pipes 46

160. Open valves 9, 11, 41, 42, 122, and place the handle of the ram control valve in the conning tower at one of the end positions. Fill the ram in a manner similar to filling the stern plane ram. Upon filling the ram, close valves 9 and 11.

Air is evacuated from pipes 46 in the way similar to evacuating air from pipes 45 by opening valve 16 and putting the handle of the vertical rudder ram control valve in compartment III at one of the end positions.

After air is evacuated, close valve 16.

Filling Bow Plane Tilting and Rig-In Rams
and Evacuating Air from Pipes 137

161. Open valves 2, 3, 14 and 135. Fill the tilting rams and evacuate air from pipes as outlined in Item 148.

After filling the tilting rams and evacuating the air from the pipes put the control valve handle to the middle position and close valves 14 and 135.

Filling One-Chamber Hoists of VAN,
RAMKA, Snorkel, FLAG and NAKAT System

162. To fill the VAN hoist, open valves 79 and 82, open a needle plug on the hoist to let air out, and put the control valve handle to HOISTING. Start the pump of compartment VII. If oil leaks through the plug, stop the pump and tighten the plug. Fill the RAMKA, Snorkel, FLAG and NAKAT hoists following the same procedure.

To fill the FLAG and NAKAT hoists, open valve 80.

On completion of filling the one-chamber hoists, put the handles of the control valves to the middle position and close valves 79 and 80.

Filling Two-Ch[illegible]
and ПК-8.5

163. To fill the ПСНП-5 [illegible] plugs on the top and bottom chambers of the hoist, shift the control valve handle to one of the end positions, start the pump of compartment VII. If the oil leaks through the plug, stop the pump, and tighten the plug.

Shift the control valve handle to the other end position, then fill the other chamber of the hoist following the same procedure.

After filling the hoist, put the control valve handle to the middle position, and close valve 7.

The ПК-8.5 hoist shall be filled in like manner through valve 125.

Filling Pipings and Hydraulic Mechanism Cylinders

164. Fill the pipings and hydraulic mechanism cylinders with the aid of a hand pump of compartment VII. For this purpose, open valves 67, 68, 88 and 89, put the control valve handle to one of the end positions.

To evacuate air open a plug on a hydraulic mechanism most distant in the given group of hydraulic mechanisms operated by this control valve, and deliver oil by the hand pump. As soon as oil leaks tighten the plug, shift the control valve handle to the other end position, and fill the other chamber of the hydraulic mechanism in the same manner.

Make certain that the most distant hydraulic mechanism is filled, then open plugs in succession and fill cylinders of the other hydraulic mechanisms of the given group.

Fill hydraulic mechanisms of other groups in the same manner.

After the hydraulic mechanisms are filled, put the handles of the control valves to the middle position, and close valves 67, 68, 88 and 89.

Filling Air-Hydraulic Accumulators

165. Open valve 109, set valves 12 and 102 to NO RETURN, and open plugs on the top covers of the air-hydraulic accumulators. Start the pump of compartment VII and completely fill the air-hydraulic accumulators. Stop the pump, close valve 109. Watch the signalling board to check the filling of the air-hydraulic accumulators.

When the pistons of the air-hydraulic accumulators are in the upper position, pour oil into the upper chamber, then screw up and tighten plugs.

To completely evacuate air from the oil chamber of the air-hydraulic accumulators, fill the air flask with air and thereupon prime the air-hydraulic accumulators by discharging them five times through valves 100 and 109.

FILLING SYSTEM, AIR FLASKS AND AIR-HYDRAULIC ACCUMULATORS WITH AIR

166. When filling the air flasks and air-hydraulic accumulators with air follow maintenance instructions on the high-pressure air system. In this case, the air-hydraulic accumulators should be completely filled with oil.

Open valves 72, 74 and fill the air-flask with oil until pressure gauge 73 or 97 reads 100 kgf/sq.cm, then close valve 72. An hour after charging, blow the air flask and piping having opened and closed valves 71 and 107. Then open valves 72, 101, 104 and 108, add air into the flask and fill the air-hydraulic accumulators with air until pressure gauges 73 and 97 read 100 kgf/sq.cm, whereupon close valve 72.

167. Upon filling the system with oil and air, check the operating mechanisms for smooth work. For this purpose, work with every mechanism separately till air is completely evacuated.

To check for absence of air, open plugs on the operating mechanisms.

Pay particular attention to priming and evacuating the air from the pipings and rams of the planes and rudders.

The rams should work [illegible] rattling.

WARNING. The hydraulic mechanisms of ballast tank vent valves should work depending on conditions of maintaining the submarine buoyancy in compliance with instructions for submergence and surfacing.

DRAINING THE SYSTEM

168. The draining of the hydraulic system involves removal from hydraulic control of all the operating mechanisms.

Therefore when draining the system, observe all the measures to insure buoyancy and unsinkability of the submarine.

Draining should be performed immediately before filling the system in case of changing oil:

(a) if analysis of oil for content of water and for solid matter (see Item 135) gives unsatisfactory data;

(b) in 12 months after the last change of oil regardless of the analysis results;

(c) during running and medium repairs;

(d) when filling the system with oil other than specified.

169. The service tank is drained only in case of unsatisfactory analysis taken from this tank.

To drain the tank, follow the procedure below.

170. Bring the system to the initial position and lower all the masts. Open valves 90, 91, 92, 93, 94 and 96 at the motor-driven pump in compartment III.

171. Open valves 100 and 109, and discharge oil from the air-hydraulic accumulators into the service tank. Close valves 100 and 109.

172. Back out nut-plug 58 on the pressure line, connect one end of hose 57 to the connection and put the other end of the hose into the reservoir on deck.

Start one of the pumps in compartment VII and drain the service tank.

Open valve 113, start the pump in compartment VII and drain the reserve tank.

Open valves 84 and 86, and using the hand pump in compartment III drain the 35-litre tank.

Should the need arise to drain the spare tank, open valve 38, open valve 28, and start the pump in compartment VII.

173. Disconnect the hose from the pressure line and plug the connection with nut-plug 58. Back out plug 55, connect to the connection a hose running from a crosspiece of pneumatic tools, open valve 136 and blow oil from the pressure and drain lines into the service tank.

Plug the connection with nut-plug 55, attach hose 57 to connection 58, close valve 66 and employing the pump of compartment VII drain the service tank again.

174. Open the upper needle plugs on cylinders of tilting rams of the bow and stern planes and of the vertical rudder. Opening the lower plugs in succession, drain oil from chambers of the cylinders into a portable container. This done, close the plugs.

175. Open drain plugs on hoists of the masts. Drain oil into the portable container, and then close the plugs.

176. Open needle plugs on both chambers of cylinders of the hydraulic mechanisms. Displacing a piston of the hydraulic mechanism by hand from one to the other end position, drain oil into the portable container, and then close the plugs.

WARNING. Drain the vent valve hydraulic mechanisms with due consideration of requirements for maintaining buoyancy of the submarine.

177. To completely drain pipings in the places where oil flow can be inhibited, release the pipe unions on pipes and drain oil from them.

178. To completely drain oil tanks, open drain cocks or plugs installed on them.

179. The oil cooler is drained into the portable container through drain plugs on oil and water chambers.

180. Every time before docking the system, remove the

top covers of the air-hydraulic accumulators to inspect working surfaces of the cylinder and piston and to change oil filled above the piston. Should burrs and other damage be detected, eliminate them.

Replace rubber packing rings of the piston if faulty.

WARNING. 1. Never unscrew plugs and never back out union nuts on covers of the air-hydraulic accumulators if they are under air pressure. When removing the covers, close valve 74, open valve 107 and relieve pressure from any air-hydraulic accumulator by opening valve 101, 104 or 108.

2. Fill, drain and prime operating mechanisms only in the presence of the attending personnel.

FLUSHING THE SYSTEM

181. The hydraulic system is flushed to remove dirt, scale and other solid matter accumulated in pipings in the process of operation of the system.

The system is flushed with the aid of a non-organic pumping plant located outside the submarine. Flushing is performed during preventive inspections and repairs and after draining unspecified oil from the system.

182. The non-organic pumping plant is positioned outside the submarine and is connected at valve 136 by means of pipes or hoses laid through companion hatch of compartment I to the pressure and drain lines.

The pumping plant output at a pressure of 20 kgf/sq.cm should be not less than 200 lit/min.

183. When flushing the system set branching link pipes at the filters, control valves and operating mechanisms to shut off the latter for the time of flushing.

The branching link pipes should be made of copper pipes 6x1.5; 9x1.5; 14x2; 22x2; 24x2; 32x2; 38x2.5; 45x2.5; 55x2.5 and of oil-resisting rubber hoses, dia.10, 15, 20, 25.

The link pipes to be attached to pipe unions must terminate in connections or coupling joints on the ends; the link

pipes to be attached to flange joints must terminate in flanges.

Note: Branches running from control valve to operating mechanism should be flushed only in case of watering the system.

184. Perform the flushing by the non-organic pumping plant continuously until fine oil filters are completely clean, but the flushing time should be not less than:

- 6 hours for pressure and drain lines;
- 4 hours for branches running to rams of planes and vertical rudder;
- 4 hours for branches running to rams of masts;
- 2 hours for remaining branches.

185. Prior to flushing the system take the following steps:

(a) fill the systems with oil;

(b) lower all the masts;

(c) set control valves of all the operating mechanisms to the middle position;

(d) lock the operating mechanisms furnished with locking devices;

(e) shut all the valves of the system.

186. When flushing the pressure and drain lines, open all bulkhead valves on pipe lines, and also valve 54. After the pipe lines are flushed, close valve 54, and flush pipes at the air-hydraulic accumulators. To this end, fit links between pipes disconnected from the air-hydraulic accumulators and connections at valves 100 and 102.

Open valves 98, 103, 105 and 106. By opening valves 12 and 109 in turn, flush the pipes, thereupon remove the links, and close the valves.

187. When flushing branches running to the rams of the planes and rudder, fit link pipes (see Item 173). By opening valves 13 and 14, 15 and 16, 17 and 18, 134 and 135 in turn, flush pipes, then remove the link pipes and close the valves.

188. When flushing the two-chamber masts (of search periscope ПК-8.5, night altiscope ПЗНГ-8), fit links (see Item 183) and open valves 6 and 7, 124 and 125 in turn.

When flushing the one-chamber masts (of VAN, RAMKA, Snorkel, FLAG and NAKAT systems), use link pipes to connect ends of the pipe running to the mast with the pressure and drain pipes, running to the control valve, and also open valve 79 and then alternately open valves 80 and 81, 82 and 83.

After the masts are flushed, remove the link pipes and close the valves.

189. When flushing the branches running to the hydraulic mechanisms of the operating mechanisms, fit links (see Item 183).

Alternately opening the pressure and drain valves before control valve units, flush pipes, then remove the link pipes and close the valves.

Start the flushing from the branches of compartment VII and proceed in succession to the branches of compartment I.

In each compartment perform the flushing so as to keep clean the branches flushed before. For this purpose, start flushing from the most distant branch of the given compartment.

190. Following the flushing of all the branches, perform the final flushing of the pressure and drain pipe lines until they are absolutely clean (see Item 186).

After the flushing is over, disconnect the non-organic pumping plant from the hydraulic system, and connect the pressure and drain pipes to valve 136.

Shut all the valves of the system.

191. Fill the system with oil, test it for tightness, and inspect the organic pumping plant system for cleanliness. For this purpose, run all the operating mechanisms and inspect the filter element of the filter installed on the drain pipe before the service tank.

Should the filter become dirty, flush the system again.

G. TESTING THE SYSTEM FOR TIGHTNESS

The system is tested for tightness to make sure that joints are tightened. The test for tightness is performed when laying or repairing the pipings as well as when performing preventive inspections and repairs.

TESTING THE AIR PIPING

192. The air piping running to the air-hydraulic accumulators and air flask should be tested for tightness with compressed air.

For this purpose, deliver compressed air from the high pressure air piping through reducing valve 72 in compliance with the procedure described in Item 166.

Build up the pressure to 100 kgf/sq.cm by 20 to 25-kgf/sq.cm stages and check the pressure against pressure gauge 73. Coat all the joints with soap-suds and inspect them at every stage of the pressure. Should air leak through any one of the joints be detected, relieve the pressure, tighten the joints and go on with testing. If the trouble cannot be corrected by tightening the joints, relieve the pressure, disassemble the joint, replace a gasket and repeat the test operation.

WARNING. Never tighten the joints under pressure.

193. Upon testing all the joints for tightness, condition the air piping together with the air flask and air chamber of the air-hydraulic accumulators for 24 hours at an air pressure of 100 kgf/sq.cm. The pressure drop should not exceed 2 per cent of the original value.

The first check of the pressure is performed 2 hours after the working pressure has been obtained.

194. To test the air piping for tightness, compressed air is delivered from the intermediate pressure air piping to the cut-off valve through valve 112 and control valve 111. When so doing, follow the maintenance instructions for intermediate pressure air piping. Build up pressure to 45 kgf/sq.cm

and check the pressure against the pressure gauge installed on the intermediate pressure air piping. When the pressure is built up, coat all the joints with soap-suds and examine them. If the air leaks through any one of the joints, follow the procedure outlined in Item 192.

TESTING THE HYDRAULIC SYSTEM

195. The hydraulic system is tested for tightness with oil, grade AY.

The oil pressure for the test operation is built up with the aid of the hand pump located in compartment III. After the desired pressure is built up, the hand pump should be disconnected by valve 84.

The value of the test pressure:

(a) 125 kgf/sq.cm for pressure piping;

(b) 32 kgf/sq.cm for drain piping.

The pressure in the pressure line is checked against pressure gauge 89a and in the drain line against pressure gauge 89б.

Note: When testing the system the hand pump of compartment VII can be employed.

196. Perform the test of the hydraulic system for tightness within the time required for examining the joints.

Should leakage be detected in any joint, open valve 100 to relieve the pressure in the system, tighten the joint and go on testing. If the oil leakage still exists, disassemble the joint, replace gaskets and repeat the test.

197. Prior to testing the hydraulic system for tightness, take the following steps:

(a) lower all masts;

(b) lock all operating mechanisms;

(c) set control valves of operating mechanisms to the middle position;

(d) close all the valves of the system, except valves 52, [illegible] and cock 51.

WARNING. When testing the pressure pipings, open valves 68 and 83 to avoid breakage of control valve electromagnets.

198. When performing the tightness test of the pressure line to stop valves of control valves, open valves 84 and 86. While testing pressure pipings of the pumping plant, open valve 98 and a respective valve of the branch under test.

199. When performing the tightness test of the drain line up to stop valves of control valves, close valve 53 and open valves 98 and 100.

200. When performing tightness test of pressure branches from stop valves to control valves, open a pressure valve of the branch under test.

201. When performing tightness test of drain branches from stop valves to control valves, close valve 53, open valves 98, 100, and a drain valve of the branch under test.

202. When performing tightness test of branches from control valves to operating mechanisms, open the pressure and drain valves which control the operating mechanism, shift the valves to one of the end positions, and examine the joints, then shift the valves to the other end position and examine the joints again.

WARNING. 1. Branches to operating mechanisms should be tested in the presence of personnel servicing the given mechanism.

2. When testing branches running to torpedo tubes, follow the maintenance instructions on the complete equipment.

TESTING THE COOLING WATER PIPING

203. The cooling water piping running to the oil cooler should be tested together with the shafting cooling water piping in compliance with description and maintenance instructions on sea water cooling piping of exhaust systems of diesels, diesel-generators, water-to-water heat exchangers and shafting.

H. REFERENCE DATA

204. When at sea, in the event of complete expenditure of oil, grade АУ, the system can be filled with a mixture of 40 per cent diesel fuel, grade ДС, and 60 per cent diesel oil, grade М14-ГИ.

On return to the base, drain unspecified oil from the system, thoroughly flush and then fill it with specified oil.

205. Gaskets in pipe unions are of copper and those in flange joints of paronite.

206. Packing in seals of air valves is greased hemp cord, 4 mm in dia.; seals in hydraulics valves, dia.50, employ cotton twist, 6x60; the other valves are packed with rings made of stamped rubber.

207. Packing rings of pistons of the air-hydraulic accumulators are made of rubber. Their life is 7 years including 2 years of storage.

208. Hoses on pressure pipings are metal braided and rubberized.

Hoses on suction pipings are rubberized.

Their life is 2 years, including the one-year storage period.

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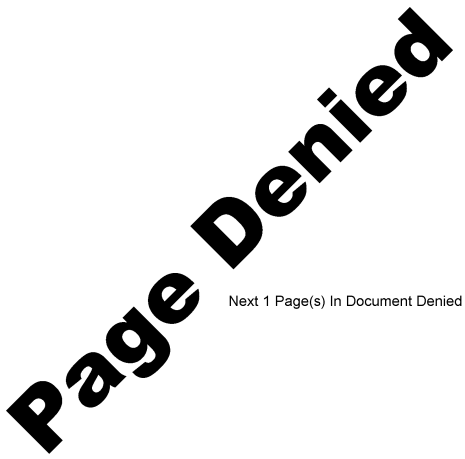

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